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(56) Documents Cited
EP 0776827 A1 US 5506032 A
US 5372183 A US 5332030 A
Online (WPI) abstract for DE003909105 A
Online (PAJ) abstract for JP580122980 A
Online (PAJ) abstract for JP550060182 A
Online (PAJ) abstract for JP070218162 A

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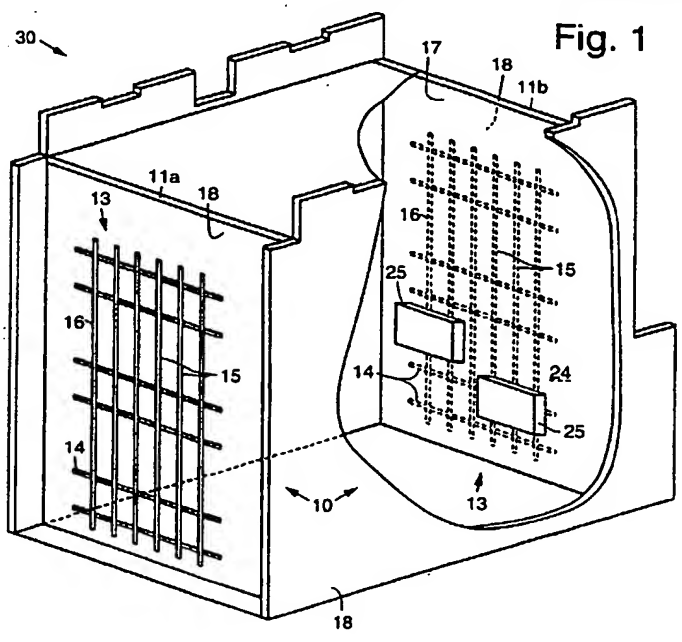
Online: EPODOC, JAPIO, WPI

(54) Abstract Title
Heat dissipating apparatus for spacecraft using heat pipes

(57) A heat dissipating apparatus 10 for use in a spacecraft comprises first and second radiator panels 11a, 11b and one or more heat pipes 14, 15 coupled to the first and second radiator panels 11a, 11b that contain a working fluid. The working fluid may comprise a selected one of: toluene, methanol, butane, water, heptane or pentane. The one or more heat pipes 14, 15 may comprise first and second heat pipe networks 13 including first and second sets of heat pipes arranged as a matrix and which are in thermal communication. The first and second radiator panels 11a, 11b may each comprise inner and outer faceskins 17, 18 wherein the one or more heat pipes 14, 15 are embedded between the inner and outer panel faceskins 17, 18 and a honeycomb core 24 disposed between the inner and outer panel faceskins 17, 18 surround the heat pipes 14, 15. The honeycomb core 24 thermally and structurally bridges the heat pipe networks 13 to the opposing faceskin 17, 18.

Fig. 1



At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

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Fig. 1

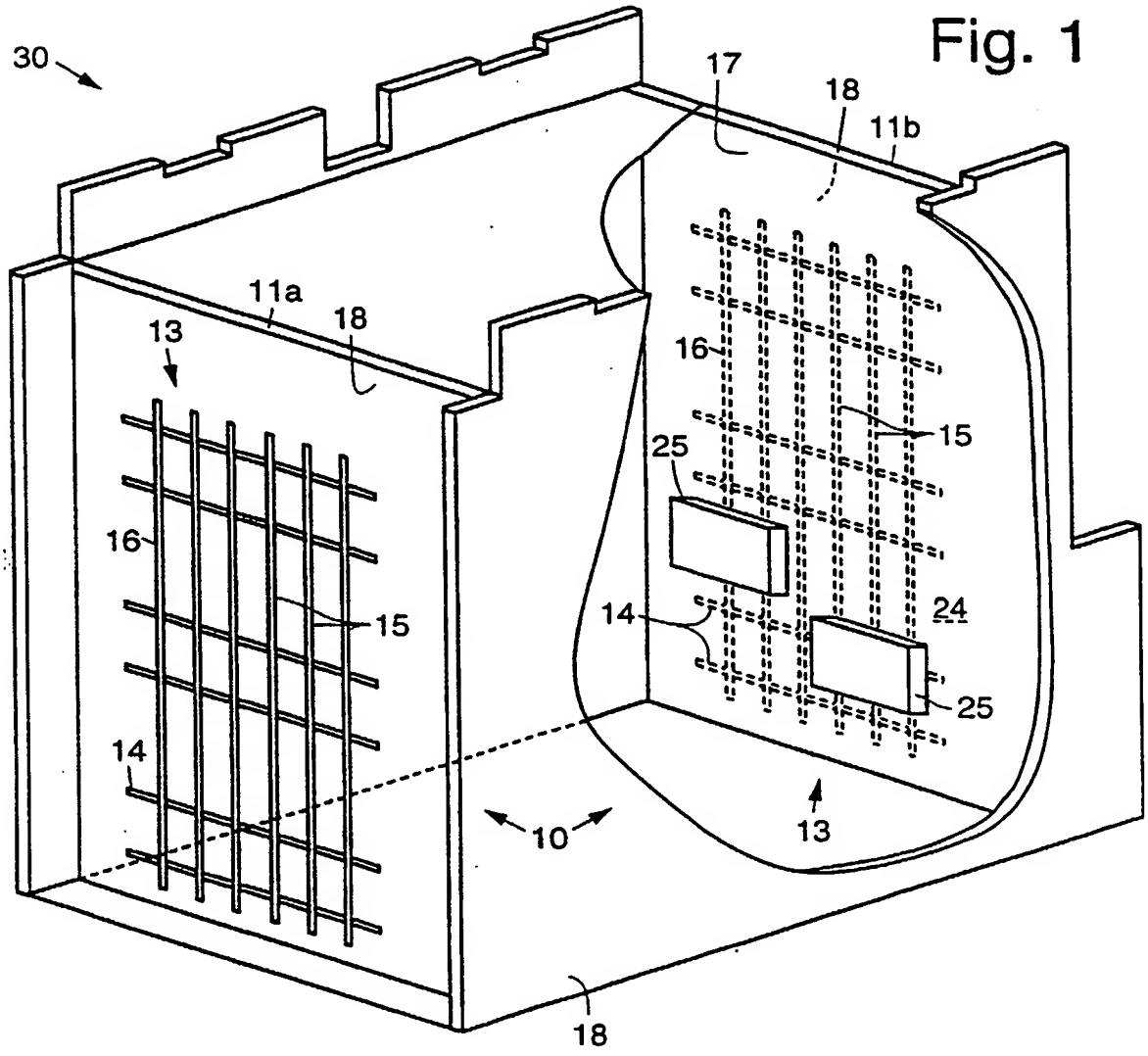
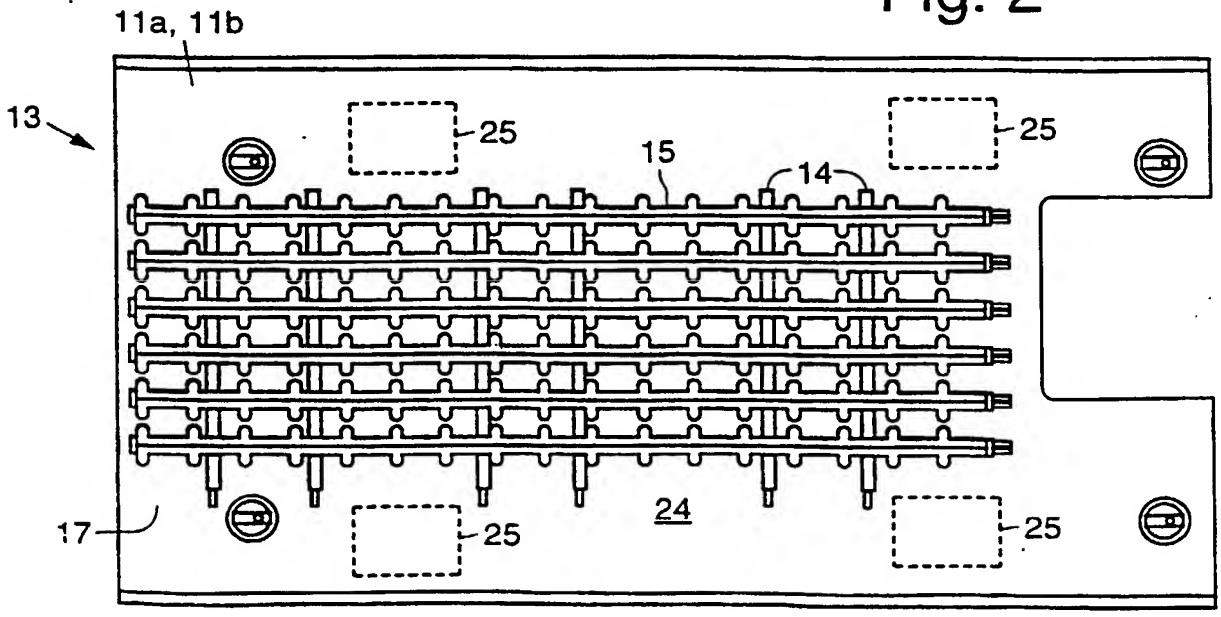

30
17
18
11b
11a
18
13
16
15
25
16
14
24
25
14
15
10
13
18

Fig. 2


11a, 11b
13
25
25
15
14
24
17
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25

SPACECRAFT HEAT DISSIPATING APPARATUS USING HEAT PIPES CONTAINING A MEDIUM TEMPERATURE WORKING FLUID

The present invention relates generally to satellites or spacecraft, and more specifically, to heat dissipating apparatus comprising a spacecraft or satellite radiator system that employs a heat pipe network containing a medium temperature working fluid.

The assignee of the present invention manufactures and deploys spacecraft or satellites into geosynchronous and low earth orbits. Such spacecraft have heat pipes that are used to dissipate heat from heat generating components and subsystems. The heat pipes transfer thermal energy from the heat generating components and subsystems to spacecraft radiator panels from which it is radiated into space. For reference purposes, conventional spacecraft radiator panels are disclosed in U.S. Patent No. 3,749,156 issued to Fletcher, U.S. Patent No. 5,351,746 issued to Mackey, and U.S. Patent No. 5,806,803 issued to Watts, for example.

Ammonia heat pipes have been extensively used on prior art spacecraft to distribute and transfer heat from heat sources. such as the power bus and RF equipment, for example, that operate at relatively low temperatures, typically in the range from -20°C to +70°C. To dissipate heat derived from heat sources that operate above this temperature, typically in the +80°C to +180°C temperature range, which is above the operating regime of conventional ammonia heat pipes, prior art solutions used massive heat sinks. Such massive heat sinks add unnecessary weight to the spacecraft and are also relatively inefficient.

The present invention seeks to provide heat dissipating apparatus for use in a spacecraft or satellite. According to a first aspect of the present invention, there is provided a heat dissipating apparatus for use in a spacecraft, comprising: first and second radiator panels; and one or more heat pipes coupled to the first and second radiator panels that contain a medium temperature working fluid. The heat dissipating apparatus comprises a network of (one or more) heat pipes containing a medium temperature working fluid, such as toluene, for example. The heat dissipating apparatus comprising the network of medium temperature working fluid, toluene-based heat pipes

efficiently dissipates heat derived from heat sources that operate at relatively high operating temperatures, typically in the +80°C to + 180°C temperature range.

The network of toluene-based heat pipes dissipates heat to spacecraft radiator panels which radiate the heat into space. The network of toluene-based heat pipes efficiently dissipates heat generated by equipment whose operating temperatures are above the operating temperature regime of conventional ammonia heat pipes.

The network of toluene-based heat pipes provided by the present invention has never before been used in spacecraft applications. The present invention provides for a significant mass savings over conventional heat sink approaches.

The present invention thus uses heat pipes containing the medium temperature working fluid to distribute and transfer heat derived from equipment that operates at relatively high temperatures, typically in the range from +80°C to + 180°C. By dissipating heat from equipment that operates at these higher temperatures using the toluene-based heat pipes, heat rejection from spacecraft surfaces via radiative heat transfer into space is significantly improved and is significantly more efficient.

The various features and advantages of the present invention may be more readily understood with reference to the following detailed description taken in conjunction with the accompanying drawing, wherein like reference numerals designate like structural elements, and in which:

Fig. 1 illustrates heat dissipating apparatus in accordance with the principles of the present invention comprising an exemplary spacecraft radiator system disposed on a typical three-axis body-stabilized spacecraft or satellite; and

Fig. 2 illustrates details of an exemplary embodiment of the heat dissipating apparatus of the present invention.

Referring to the drawing figures, Fig. 1 illustrates heat dissipating apparatus 10 in accordance with the principles of the present invention comprising an exemplary spacecraft radiator system 10 employed in a typical three-axis body-stabilized spacecraft 30 or satellite 30. The exemplary heat dissipating apparatus 10 or spacecraft radiator system 10 comprises first and second radiator panels 11a, 11b that each include one or more heat pipes 14, 15 that form a heat pipe network 13. The locations of the radiator panels 11a, 11b are exemplary, an may be located on any surface of the

spacecraft 30. For example, the radiator panels 11a, 11b may be located on east and west, north and south and/or aft and earth sides or surfaces of the spacecraft 30.

In a first embodiment of the present invention illustrated in Fig. 1, the heat pipe network 13 is embedded between inner and outer panel faceskins 17, 18 of the respective radiator panels 11a, 11b. A honeycomb core 24 is disposed between the inner and outer panel faceskins 17, 18 and surrounds the respective heat pipe networks 13 that are embedded therebetween. The honeycomb core 24 thermally and structurally bridges the heat pipe networks 13 to the opposing faceskin 17, 18.

Each heat pipe network 13 comprises first and second heat pipes 14, 15, or first and second sets of heat pipes 14, 15, arranged as a matrix, for example, and which are in thermal communication. The first set of heat pipes 14 (or lateral heat pipes 14) are roughly perpendicular to the second set of heat pipes 15 (or header heat pipes 15). In the first embodiment, heat dissipating equipment 25 is mounted adjacent to the first set of lateral heat pipes 14 on the inner panel faceskins 17 of the first and second radiator panels 11a, 11b. The second set of header heat pipes 15 is used to efficiently distribute the heat derived from the heat dissipating equipment 25 to the respective outer panel faceskins 18.

Fig. 2 illustrates details of an exemplary second embodiment of the heat dissipating apparatus 10 of the present invention. In the second embodiment, and as is shown in Fig. 2, the heat pipe network 13 is secured to an outer surface of the radiator panels 11a, 11b. In the second embodiment, the heat dissipating equipment 25 is secured to an inner surface of the radiator panels 11a, 11b (the rear surface of the radiator panel 11a shown in Fig. 2).

The heat pipe networks 13 contain a medium temperature working fluid, such as toluene, for example. Other examples of the medium temperature working fluid include methanol, water, butane, heptane and pentane, for example. The heat dissipating apparatus 10 comprising the medium temperature working fluid, toluene-based heat pipe networks 13 efficiently dissipates heat derived from the heat dissipating equipment 25. The heat dissipating equipment 25 comprise heat sources that operate at relatively high operating temperatures, typically in the +80°C to + 180°C temperature range.

The toluene-based h heat pipe networks 13 dissipates heat to the outer panel faceskin 18 of the radiator panels 11a, 11b, which in turn radiate the heat into space. The toluene-based heat pipe networks 13 thus efficiently dissipates heat generated by

equipment 25 whose operating temperatures are above the operating temperature regime of conventional ammonia heat pipes.

The present invention provides for a significant mass savings over conventional heat sink approaches using the massive heat sinks discussed in the Background section. Also, by using the toluene-based heat pipe networks 13, the present invention is able to dissipate heat derived from equipment 25 that operates at higher temperatures compared with conventional heat pipe systems. Consequently, heat rejection from spacecraft surfaces via radiative heat transfer into space is improved and is significantly more efficient.

Thus, heat dissipating apparatus comprising a spacecraft or satellite radiator system that employs a heat pipe network containing a medium temperature working fluid has been disclosed.

CLAIMS

1. A heat dissipating apparatus for use in a spacecraft, comprising:

first and second radiator panels; and

one or more heat pipes, coupled to the first and second radiator panels that contain a medium temperature working fluid.

2. An apparatus according to Claim 1, wherein the medium temperature working fluid comprises a selected one of: toluene, methanol, butane, water, heptane or pentane.

3. An apparatus according to Claim 1 or 2, further comprising heat dissipating equipment thermally coupled to the heat pipes.

4. An apparatus according to Claim 1, 2 or 3, wherein the one or more heat pipes comprise first and second heat pipe networks including first and second sets of heat pipes arranged as a matrix and which are in thermal communication.

5. An apparatus according to Claim 4, wherein the first set of heat pipes are generally perpendicular to the second set of heat pipes.

6. An apparatus according to any preceding Claim, wherein the first and second radiator panels each comprise:

inner and outer panel faceskins;

wherein the one or more heat pipes are embedded between the inner and outer panel faceskins; and

a honeycomb core disposed between the inner and outer panel faceskins that surround the heat pipes.

7. An apparatus according to any of Claims 1 to 6, wherein the first and second radiator panels each comprise:

inner and outer panel faceskins;

a honeycomb core disposed between the inner and outer panel faceskins; and

wherein the one or more heat pipes are mounted on a selected one of the inner and outer panel faceskins.

8. An apparatus according to any preceding Claim, comprising a plurality of heat pipes coupled to the respective radiator panels.

9. An apparatus according to Claim 8, wherein the plurality of heat pipes are disposed between the inner and outer panels.

10. An apparatus according to Claim 8, wherein the plurality of heat pipes are mounted on selected ones of the inner and outer panels.

11. An apparatus according to Claim 6, wherein the honeycomb core thermally and structurally bridges the heat pipe networks to opposing faceskin.

12. An apparatus according to Claim 6, further comprising heat dissipating equipment thermally coupled to inner surfaces of the inner and outer panel faceskins.

13. An apparatus according to any preceding Claim, wherein the heat dissipating equipment operates at temperatures between +80°C to + 180°C.

Application No: GB 0117434.1
Claims searched: 1-13

Examiner: Kalim Yasseen
Date of search: 7 January 2002

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.S): F4U (U25A, U25B)

Int Cl (Ed.7): B64G (1/50); F24D (15/00); H05K (7/20)

Other: Online: EPODOC, JAPIO, WPI

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
X, Y	EP 0 776 827 A1	(HE) an example of a satellite having two radiators 30, 32 with a heat pipe network, see whole document	X:1-13 Y:2
X	US 5 506 032 A	(MARTIN) a structural panel radiator having a plurality of heat pipes, see whole document	1-13
X	US 5 372 183 A	(STRICKBERGER) an example of a satellite having at least two radiators with a heat pipe network, see whole document	1-5, 8, 13
X	US 5 332 030 A	(SPACE) an example of a satellite having two radiators 20, 24 with a heat pipe system, see whole document	1
Y	Online (WPI) abstract for DE003909105 A, example of a heat pipe using methanol as heat transfer fluid		2
Y	Online (PAJ) abstract for JP580122980 A, example of a heat transfer apparatus which uses water, pentane, heptane as heat transfer fluids		2
Y	Online (PAJ) abstract for JP550060182 A, example of a heat pipe using butane as the working fluid		2

X Document indicating lack of novelty or inventive step
Y Document indicating lack of inventive step if combined with one or more other documents of same category.
& Member of the same patent family
A Document indicating technological background and/or state of the art.
P Document published on or after the declared priority date but before the filing date of this invention.
E Patent document published on or after, but with priority date earlier than, the filing date of this application.

Application No: GB 0117434.1
Claims searched: 1-13

Examiner: Kalim Yasseen
Date of search: 7 January 2002

Category	Identity of document and relevant passage	Relevant to claims
Y	Online (PAJ) abstract for JP070218162 A, example of a heat transfer device using toluene as a heat transfer medium	2

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.